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FROM
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THE

ELECTIVE SYSTEM

IN

TECHNOLOGICAL SCHOOLS.

BY

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THE ELECTIVE SYSTEM AS ADOPTED IN THE MICHIGAN MINING SCHOOL.

BY M. EDWARD WADSWORTH,

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In the United States two systems have been chiefly followed in the higher educational institutions—the Fixed and the Elective. The latter was introduced first in this country by President Wayland, of Brown University, and it has since been systematized and developed with remarkable skill and success by President Eliot, of Harvard. Indeed, the system has proved to be so well adapted to the needs of modern times, and to be so popular, that it has made its way in the face of strenuous opposition, until all or nearly all of our colleges and universities have employed it for their work in general or literary, and scientific education.

In technical or engineering education the case has been different, since even those colleges, like Harvard, Leland Stanford, or the University of Michigan, which have a most liberal elective system for general education, have still only a partially modified form of the rigid system in the engineering or technical courses. The rigid system is disguised in most institutions in their technical work under the head of election between various fixed courses, which may or may not have a few options, or it masquerades under an elective dress to which it has but little, if any, right.

The elective system proper in any of the higher institutions giving general education, consisted of two features: 1st. The Essential Studies. 2d. The Se-

quence of Studies. The first is composed of those studies which are considered in each institution as necessary, or essential to maintain the scholarship or traditions of the school in question, and in engineering courses, not even excepting that at Harvard, the required or essential studies to-day constitute the chief amount of the entire course in any of the engineering branches. In the case of general or literary education, the number of studies that are considered essential usually rapidly diminishes, according to the experience and number of the faculty, until only a few studies are required; and in time this feature will be fully eliminated.

Regarding the second, or "The Sequence of Studies," but little public attention is called to it in any statements relating to electives in any institution, although it is the keynote of them all. No school can maintain any elective system, or any work above a kindergarten or primary grade, without carefully considering the question of the natural sequences. It is the unwritten law that no student can take calculus who has not previously prepared himself in algebra, nor can he study petrography without any knowledge of mineralogy.

All the catalogues of the advanced institutions show that they tacitly recognize the law of sequence of studies with greater or less fullness, but I do not know of any which call attention to the fact, except the recent prospectus of the Michigan Mining School.

In truth, the greatest curses that beset any system of electives are the neglect of proper sequences in the studies, and the tendency of various instructors to bid

for students by giving weak and inferior (technically known as *soft*) courses. This last, like many of the other ills of educational institutions, can be partially, if not entirely, removed by placing the charge of the instruction under one experienced executive head, which head is to be held strictly accountable for the success of the work, and is to be given absolute control over all the instructors, with power to discharge them if they do not properly perform their functions. In other words, there should be introduced into our colleges more of the business methods of successful business houses—the direct responsibility for and power of the individual over everything placed under his charge.

The Michigan Mining School has attempted, so far as the institution's province of training men to assist in the development of the mineral wealth of the country will enable it to do so, to apply to technical or engineering education, the methods in use in the elective systems employed for general or literary instruction. In accomplishing this it has tried to reduce to a minimum all studies to be taken by every student, to conserve the sequence, and to obtain thorough work by the business method of individual responsibility.

The only studies required of all the pupils here are Elementary Geology and the Elementary Principles of Mining; these are asked for, because it is believed that in any institution dealing with the problems relating to the mineral wealth the pupil should have some knowledge of geology and of mining methods, and also because the Director (who in this case happens to be in charge of the geological instruction) desires to come

into personal contact with every pupil in the school, early in his course. The above-mentioned studies require, altogether, the pupil's presence in the classroom, only three times a week for thirty-four weeks.

Outside of the Elementary Geology and Mining the student is allowed unrestricted freedom of choice in his studies, the same as he is in the literary, but not in the engineering, courses of Harvard, Michigan, or in any other of our Universities.

Emphasis is here placed upon the almost absolute freedom of choice at the Mining School, because many have mistaken the natural "sequence of studies" for "required studies." This error happens because in the prospectus of the elective system, issued last May, special attention was called to the natural sequences in chemistry, metallurgy, mechanical, electrical and mining engineering, ore-dressing and geology, provided any student wished to obtain every particle of instruction that is given in the Mining School in any of the subjects named. These outline schemes are merely signs showing the student some of the numerous ways of reaching the upper rooms of the house, but he has absolute freedom to use any of the other numerous ways that might just as well have been pointed out. Owing to the fact that in the usual discussions of elective systems the natural sequence of studies is not dwelt upon, it was expected that these guiding lines would be mistaken for required courses by many readers, although it was thought the error was sufficiently guarded against in the prospectus on pages 11, 13, 14 and 25. The precaution seems not to have been entirely successful, since a friendly hand in a friendly journal* has

* American Geologist, 1895, XVI., 130.

penned the following: "Students are allowed to select one of several courses with a certain principal subject, and in each course certain studies are required and the rest are elective. The school thus allows greater freedom in the selection of studies than do most mining schools." This friend has entirely misapprehended the facts, as the statements made above show. The freedom of choice is not only greater than that allowed in all other mining schools or colleges, but, so far as the present writer is aware, also greater than that in all other technical or engineering colleges whatsoever.

Although this is the first time this general freedom has ever been granted in any engineering college, the problem seemed to be so fully solved, so far as the special conditions of this institution are concerned, that when it was brought before the Faculty and the Board of Control it passed both bodies without a single objection. The ostensible working of the system does not go into full effect until September 16th of this year, yet the choice of electives has already been made, and the passage of all the students from a rigid system to an elective one has been accomplished without any hitch or difficulty, and also with the students' unanimous approval.

The courses in operation up to the time of commencement, August 16th of this year, were two exceedingly rigid ones. The required work demanded of the student from seven to ten hours a day, five days a week, for forty-five weeks a year, and for three or four years (according to which course was taken) in the class room, laboratory, field, mine, or mill, while his daily preparatory work had to be attended to in

outside time. When it is considered that all students, both special and regular, have been transferred, not only without trouble, but with general satisfaction, from one system to the other, the success seems almost phenomenal.

In the elective system of the Michigan Mining School the unit of work is taken as three hours a week in the class room, or nine hours a week in the laboratory, for thirty-four weeks; and this amount of work is called a course or a full course, while any subject scheduled in the prospectus for less time is taken for its proportionate part of a full course. The student, to obtain the degree of Bachelor of Science, must complete eighteen full courses, and to obtain that of Mining Engineer, twenty-two full courses, which in both cases include the subjects of Elementary Geology and Mining.

Owing to the fact that the regular work in the Michigan State Mining School extends through forty-five weeks of the year, a good student can obtain his degree in three or four years, depending upon the question of whether he remains during the entire forty-five weeks each year, or for only the first thirty-four weeks, or also whether he wishes his course to be largely of practical or of theoretical work.

At the present time this institution has announced sixty-five different subjects or studies from which the pupil can make up his eighteen or twenty-two courses, only one of these full courses being of required work. In a required system of study the pupil can be carried over all the subjects that experience considers necessary for the successful prosecution of his future pro-

fession, but this is always done at the expense of thoroughness, and it pays but little or no attention to the individuality of every student or to the rapidly increasing specialization of work in every subject. It gains breadth, but it is at the expense of depth.

In an elective system the individuality of the student, the specialization of work in modern times, and the limitations of human capacity, are all considered. It loses in breadth, but it gains in the greater interest and, consequently, greater depth of the work done.

Much can be said in favor of both systems, as the writer knows from long experience with both; but there is one point that ought to be the controlling factor in every engineering college in deciding what it will do for the future. If the signs of the times and the history of education are read aright, this is true and certain, that whether we like the elective principle or not, whether we are willing to adopt it or not, every engineering or technical college in the land must and will adopt it in its entirety sooner or later, or else perish. It needs no Daniel to read the handwriting all over our walls.

DISCUSSION.

PROF. MANSFIELD MERRIMAN said that in regard to courses in mining it seemed to him that there was a greater freedom in choice and arrangement of the subjects than in any other kind of engineering courses; that it was also very true that the number of students had decreased in a marked degree within a few years. Some mining courses, in fact, had gone out of existence altogether, owing to lack of students. He thought that the freedom of election had been one of the causes

of the students leaving the mining course of study and going into chemistry and civil engineering. The systematized courses appeared to be far the best, and if options were allowed, it seemed preferable that they should be confined to the senior year.

PROFESSOR J. GALBRAITH felt that a system of the kind proposed in the paper was surrounded with great difficulties. If the student were to be left perfectly free in the choice of the courses of study these courses would require to be perfectly self-contained, and there might be a great amount of overlapping in those selected by a student for his diploma. This overlapping means waste of time and labor. If the courses are arranged so that the number of combinations is very limited the students will be obliged to consult their teachers as to the best sets of combinations. Thus the so-called elective system will resolve itself into something very like the authoritative system. Students, as a rule, are not qualified to select the various courses necessary for an engineering diploma. The experiment will be watched with interest. It appears to the speaker that a great deal of the desire at present noticeable among students for freedom of choice in their studies arises from their false conception of the German student. The latter is given in the university great freedom. Our students see this, but they forget or do not know that the German student has already gone through a discipline of the most severe kind, stretching over eight or nine years in the gymnasium or the Real schule, which has little or no counterpart in this country.

PROFESSOR JOHN M. ORDWAY would distinguish in

this matter between the option of subjects and the option of courses. The students should be required to take up certain subjects, such as hydraulics. Mining engineering might be divided into two or three different sections. One would involve more chemistry, another more of civil engineering and another more of mechanical engineering. The student should be allowed to choose one of those courses and the subjects that belong to it, and not to select individual subjects.

PROFESSOR HEINRICH O. HOFMAN explained that at the Massachusetts Institute of Technology a few years ago there were in the mining department four different options with special reference to mechanical, civil and chemical studies, in order to satisfy the demands, in addition to the general mining and metallurgical course which a student took, if he showed no special preference for any of these branches. After a few years these options were found to work unsatisfactorily and this for two reasons: First, they required a larger number of special teachers than it could very well be demanded of any school to furnish; and secondly, students who had chosen one of the three special options found that the situations open to them after graduation were probably not in the special line they had selected. The department had now dropped two of the options, retaining the one in which the main study was mechanical engineering. It advised every student who did not know definitely that he was to enter the iron and steel industry to take the general course as the only satisfactory way of thoroughly equipping himself to take up any branch of practical work.

AUTHOR'S CLOSURE.*

The author desires to thank those who took part in the discussion for supporting so fully the positions taken by him in his paper. He regrets that not one of the speakers grasped the cardinal point of the whole matter—THE SEQUENCE OF STUDIES. If the elective studies are arranged according to their true and natural sequence, and the instruction in each one is so given as to teach the student that which he must know at that stage of his course, none of the evils which have been so gravely feared can come into actual existence.

If the work is not so arranged, troubles may occur, not because the system itself is defective, but because those who have planned its details have committed errors of judgment.

An elective system, such as mentioned by Professor Galbraith, could exist nowhere outside of a primary school. His remarks appear to have no bearing whatever upon the system under discussion, since in this system overlapping is impossible, while it *is* a common and almost necessary evil where optional or parallel courses are offered.

Elective studies and election of rigid courses, called options, seem to have been generally confounded in the discussion. The author objected to the latter as being in no wise electives, but only rigid courses merely masquerading as electives. Professor Hoffman contributes valuable testimony as to the inefficiency of these, and his statements of the undesirable

*Communicated March 9, 1886.

results at the Massachusetts Institute of Technology will be accepted by the author and others as authoritative.

In reply to Professor Ordway, it may be pointed out that whether hydraulics or any other subject is to be taken depends on the end the student desires to reach. Such matters are fully provided for by the sequence of studies, since every instructor has the right to, and is obliged to, demand that each student, before being admitted into his class, must have completed every preparatory subject essential to the work of that class. This procedure is a necessary part of the system.

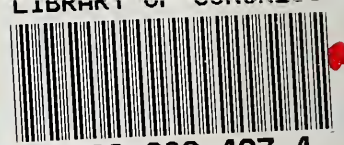
The author has had over thirty-two years' experience with single rigid courses, optional courses and free elective studies. Which system should be adopted depends on special conditions peculiar to each institution. His own experience leads the author to believe that the elective system, as already described, is superior to the others, when guided by a strong and judicious hand, and properly guided by a united and competent Faculty.

The apparent decadence of interest in mining engineering in many institutions, as mentioned by Professor Merriman, is the natural and only logical result flowing from well-known causes which have already been pointed out in the author's published reports.* One of these causes is the location of the college in a region whose people are indifferent to the technical or engineering interests involved, and where the student is not in daily contact with practical applications of

*Report of the Director of the Michigan Mining School, 1886-1891. pp. 25, 34, 35 and 37.

the subject he is studying. Money can not buy equipment enough to overbalance the influence of an unsuitable location. Another cause is the overshadowing of the mining courses by other technical courses which are more fostered and developed by the special surroundings of the college. A third and most potent cause is the fact that most courses of mining engineering are made up of shreds and patches—mere excerpts or leavings from other technical courses, instead of being solid, systematic, and thoroughly worked-out schemes to train men to develop the mineral wealth of the country.

The history of education in America seems to point out that the wisest course is to provide institutions which are devoted to a single technical purpose, and in thorough harmony with their surroundings. Otherwise the tendency is very great for the strong courses to crowd out the weak ones. So true is this that there probably can not be found in the United States over four colleges which stand really distinguished in more than one engineering line.



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